Using performance records in beef production

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USING PERFORMANCE RECORDS IN BEEF PRODUCTION

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AGDEX 420/30

The productivity and profitability of beef production can be increased through the use of performance records. Once identified, superior animals may be kept as breeding stock, thereby improving the performance of future generations. Many programs offer performance records to producers. These include: the Ontario Beef Herd Improvement Program (BHIP); the Ontario Bull Test program; the Canadian Beef Sire Monitoring program as well as several programs offered by breed associations. Each of these programs identifies the genetic component of traits so that superior animals may be selected for breeding and inferior cattle may be culled.

Any measurable trait of an animal (phenotype) is due both to genetics (genotype) and to the environment in which that animal was raised (environment). This relationship is often expressed as phenotype = genotype + environment or P = G + E. The process of selection is advantageous because genetically superior animals will pass on part of their genotype to their offspring. Animals that appear superior because they were raised in a favourable environment cannot pass this superiority on to their offspring. All performance programs attempt to eliminate environmental influences when comparing animal performance in order that the genetic component may be identified.

Unlike many other commodities (eg. poultry, swine), beef is produced under conditions that vary greatly from farm to farm. Housing, feed type and availability, available labour and marketing procedures are some factors that depend upon the producer and his available resources. Because of this variability in production systems, each producer must identify which animals will be superior for his particular enterprise. This worksheet assists producers in determining which traits are of most importance and how these may be selected for.

ONTARIO BEEF HERD IMPROVEMENT PROGRAM (BHIP)

The objectives of BHIP are to encourage record keeping and to provide information for use in management, culling and selection decisions. Information provided through BHIP includes: weaning index, gain index (post-weaning), composite index, birth weight, adjusted weaning and yearling weights, and calving interval. The calculation and interpretation of these values are shown in the examples below. All tables used in the calculation of a weaning index are included in order that producers not enrolled in BHIP may generate indexes for their own use. The examples all involve a heifer calf born to a 3-year old Simmental cow bred by a Limousin bull. The heifer weighed 75 pounds at birth, 525 pounds at weaning (197 days of age), and 910 pounds at 355 days of age.

Example Data:

Breed of sire	Limousin
Breed of dam	Simmental
Age of dam	3 years
Sex of calf	female
Birthweight	75 lb
Weaning weight	525 lb
Age at weaning	197 days
Post-weaning weight	910 lb
Post-weaning age	355 days

Weaning index

Calculation	*Example*
1. Calves are compared only with others in the same management group. (Similar housing, feed, etc.)	At least 5 calves born within a 90 day period and raised in a common environment.
2. Preweaning average daily gain is calculated as: $\frac{\text{weaning weight} - \text{birth weight}}{\text{age at weaning}}$ Weaning weight must be taken between 120 and 250 days of age. If birth weight is not recorded, breed averages are used for sire and dam contributions with adjustments made for age of cow (Table 1). Birthweight of twin calves is adjusted downward by 30% if table values are used.	$\frac{525 - 75}{197} = 2.28$ lb/day If birth weight had not been recorded, the value of $\frac{79.9 \text{ (sire)} + 81.7 \text{ (dam)}}{2}$ or 81 lb would be used.
3. Calves of young cows are at a disadvantage since milk production is higher for older cows. The average daily gain of calves from immature cows (less than 5 years old) is adjusted upwards to account for this (Table 2).	2.28 + .108 = 2.39 lb/day
4. In order to allow comparison of all calves, regardless of sex, average daily gain is adjusted to a bull basis. Rate of gain for heifers is increased by 10%, that of steers by 5% for the period of time since castration, while that of bulls remains the same.	2.39 + (2.39 x .10) = 2.63 lb/day
5. We now compare the adjusted average daily gain to the average for that management group to arrive at a weaning index.	Assuming an average adjusted rate of gain of 2.35 lb/day for the management group, weaning index equals: $\frac{2.63 \times 100}{2.35} = 112$

When calculating a weaning index for twin calves (both raised by their mother), add 20% to their adjusted average daily gains. Compare these gains to the calculated management group average with the twin values not included.

Interpretation:

The weaning index value of 112 indicates that the adjusted preweaning gain for this heifer was 12% higher than the average for the same management group. Weaning indexes can be used to compare calves of different management groups. Adjusted weaning weight cannot be used for this purpose since differences in environment (eg. creep feeding) have not been accounted for. Weaning indexes are not calculated for foster or embryo transfer calves since they are not raised by their natural mothers. The weaning index is a measure of pre-weaning growth rate due both to the genetics of the calf and the milking ability of the dam. Thus, it is a good tool for selection of replacement heifers.

Table 1. Breed average birth weights by sex of calf and age of dam.*

	Age of Dam (years)							
	Male calves				Female calves			
Breed of dam	2	3	4	5+	2	3	4	5+
Angus	74.1	76.6	77.5	77.5	68.9	71.0	71.8	72.0
1/2 Charolais Charolais	85.2	88.0	90.2	90.8	79.1	82.7	84.4	84.7
Hereford	76.4	79.1	80.7	81.4	71.4	74.1	75.2	76.2
1/2 Limousin Limousin	78.0	81.6	83.6	85.8	72.4	76.3	78.7	**79.9**
1/2 Maine Anjou Maine Anjou	86.6	90.9	92.4	93.1	78.3	82.7	84.0	87.3
Shorthorn	74.7	75.6	76.1	77.5	69.1	70.6	71.4	72.0
1/2 Simmental Simmental	85.1	87.3	89.8	91.5	78.6	**81.7**	83.4	84.8
British Cross Others	77.2	79.2	82.0	82.5	72.4	74.5	76.3	77.0

* To find the sire's contribution to birth weight, use the value for a mature dam of the same breed as the bull.

Table 2. Age of dam adjustment factors for preweaning gain (lb/day).

	Age of Dam (years)					
	Male calves			Female calves		
Breed of dam	2	3	4	2	3	4
Angus	.1715	.0675	.0040	.1395	.0625	0
Charolais	.3335	.1810	.0435	.2650	.1455	.0555
1/2 Charolais	.2905	.0990	.0665	.1960	.0965	.0405
Hereford	.2350	.1355	.0510	.1900	.1145	.0485
Limousin	.3565	.1840	.0710	.2615	.1260	.0665
1/2 Limousin	.2025	.1040	0	.2590	.1015	.0365
Maine Anjou	.3325	.1180	0	.2925	.1255	.0225
1/2 Maine Anjou	.2775	.1400	.0455	.2015	.1090	.0490
Shorthorn	.1760	.1020	.0370	.1460	.0640	.0270
Simmental	.3200	.1600	.0590	.2360	**.1080**	.0230
1/2 Simmental	.3415	.2070	.1050	.2820	.1415	.0445
British Cross	.2785	.1485	.0565	.2180	.1195	.0370
Others	.2995	.1465	.0590	.2345	.0900	.0365

Gain Index (post weaning)

Calculation	*Example*
1. Post-weaning rate of gain is calculated as:	
post weaning weight − weaning weight	910 − 525 = 2.44 lb/day
post weaning age − age at weaning	355 − 197
Post weaning weight must be taken between 120 and 210 days after measurement of weaning weight.	
2. Rate of gain is compared to the average of the management group	Assuming an average gain of 2.22 lb/day for the management group, gain index equals: $\frac{2.44}{2.22} \times 100 = 110$

Interpretation:

Gain index is an indicator of genetic potential for post weaning rate of gain.

Composite Index (pre and post-weaning)

Calculation	*Example*
1. Find the average of weaning and gain indexes.	$\frac{112 + 110}{2} = 111$

Interpretation:

Composite index is an indicator of total productivity to one year of age. This value is of most use in heifer selection for those producers who feed their own calves to market finish.

Adjusted Weaning Weight

Calculation	*Example*
1. Find adjusted pre-weaning rate of gain (steps 1 through 4 in calculation of weaning index, including twin adjustments when necessary).	2.63 lb/day
2. Calculate adjusted weaning weight as: birth weight + (adjusted rate of gain x 200)	= 75 + (2.63 x 200) = 601 lb.

For twin calves, actual birth weight is adjusted upward by 30%. No adjustment is made to table values.

Interpretation:

Adjusted weaning weights may be used to compare animals in the same management group for productivity to weaning regardless of sex, age of dam, or age of calf. Accurate comparisons cannot be made across management groups using adjusted weaning weights! Adjusted weaning weight includes birth weight whereas the weaning index separates birth weight and pre-weaning gain into two distinct traits. Weaning index and actual birthweight may be used by producers who wish to increase productivity to weaning (select for weaning index) while avoiding excess calving difficulty (avoid high birth weights).

Adjusted Yearling Weight

Calculation	*Example*
1. Calculate adjusted yearling weight as: adjusted weaning weight + (post weaning rate of gain x 165)	= 601 + (2.44 x 165) = 1004 lb.

Interpretation:

Adjusted yearling weight is an indicator of productivity to one year of age. This value includes birth weight, whereas the composite index allows birth weight to be considered as a separate trait.

The value calculated for adjusted yearling weight may seem high relative to the actual weight taken near one year of age (eg. 1004 lb. adjusted yearling weight vs. 910 lb. at 355 days of age). This is a result of adjustment to a mature dam and bull calf basis. The apparent discrepancy between yearling weight and adjusted yearling weight will be greatest for heifer calves born to immature cows. The adjusted yearling weight, however, is the correct value to use when comparing heifers within a management group on the basis of productivity to one year of age.

Interpretation

The weaning index value of 112 indicates that the adjusted preweaning gain for this heifer was 12% higher than the average for the same management group. Weaning indexes can be used to compare calves of different management groups. Adjusted weaning weight cannot be used for this purpose since differences in environment (eg. creep feeding) have not been accounted for. Weaning indexes are not calculated for foster or embryo transfer calves since they are not raised by their natural mothers. The weaning index is a measure of pre-weaning growth rate due both to the genetics of the calf and the milking ability of the dam. Thus, it is a good tool for selection of replacement heifers.

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Calculation | *Example*

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Post weaning weight must be taken between 120 and 210 days after measurement of weaning weight.

2. Rate of gain is compared to the average of the management group

Assuming an average gain of 2.22 lb/day for the management group, gain index equals:

$$\frac{2.44 \times 100}{2.22} = 110$$

Interpretation:

Gain index is an indicator of genetic potential for post weaning rate of gain.

Composite Index (pre and post-weaning)

Calculation | *Example*

1. Find the average of weaning and gain indexes.

$$\frac{112 + 110}{2} = 111$$

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Composite index is an indicator of total productivity to one year of age. This value is of most use in heifer selection for those producers who feed their own calves to market finish.

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$$\text{birth weight} + (\text{adjusted rate of gain} \times 200) = 75 + (2.63 \times 200) = 601 \text{ lb.}$$

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Calving Interval

Calving interval is calculated as the number of days from birthdate of last calf to birthdate of present calf. A calving interval of 365 days or less is desirable in order that all cows calve once per year during a specified calving season. Calving interval indicates the fertility of individual cows, however, the fertility of the bull may also have an effect.

ONTARIO BULL TEST PROGRAM

The purpose of the Ontario Bull Test program is to allow the comparison of bulls from various herds for several economically important traits. By providing a common environment and indexing bulls relative to others in the same group, one can compare bulls for post-weaning rate of gain regardless of breed or location and time of testing. A more complete description of the program can be found in the factsheet entitled "Ontario Bull Test Program" Agdex 420/41. This program provides the following information:

Gain Index: An indicator of a bull's genetic potential for postweaning growth rate. Average index for Hereford is 100, with increments of 3 index points above or below 100 equaling 1/10 of one lb. per day in potential for rate of gain. Bulls may be compared across breeds and across stations through use of the gain index.

Backfat: An ultrasonic measurement of fat depth over the ribeye at end of test. When considered along with age and weight, backfat is a good indicator of finishing ability.

Scrotal Circumference: An indicator of a bull's fertility and that of his daughters. Bulls that do not meet breed minimums at end of test may be less fertile and their daughters late in reaching maturity. As with backfat, weight and age should be considered when comparing bulls on the basis of scrotal circumference.

Hip Height: An end of test measurement of height at the hip that may be used along with weight and backfat as an indicator of body type and conformation.

CANADIAN BEEF SIRE MONITORING PROGRAM

The Canadian or National Beef Sire Monitoring Program (NSMP) uses progeny records to provide information on bulls for calving ease, weaning weight, and yearling weight. Performance records are summarized into expected progeny differences (EPD's). Weaning and yearling weight EPD's indicate how much above (positive EPD) or below (negative EPD) breed average the progeny of a specific sire are expected to be. For example, a Hereford bull with a weaning weight EPD of +15 would be expected to sire calves that weighed an average of 15 pounds more at weaning than calves sired by an average Hereford (EPD of 0). One cannot compare EPD's across breeds. Calving ease EPD's are related to the percentage of calves expected to be born unassisted. The more positive the calving ease EPD, the higher the percentage of unassisted calvings. Again, these values are breed specific with zero being breed average. An annual summary showing expected progeny differences is available at local agricultural offices.

SUMMARY OF TRAITS

There are many traits that may affect the profitability of beef production. Selection should be made only for those traits that are both economically important and at least moderately heritable. Economically important traits that are low in heritability should be improved by culling poorer animals. The more highly heritable a trait, the higher the portion of genetic superiority that is passed from one generation to the next. Response to selection will be much higher for traits of high heritability. Table 3 summarizes some important traits, their approximate heritabilities and sources of information that can be used when selecting for each. Other traits such as temperament, horn condition, colour, etc. may also be important.

Table 3. Summary of some important traits in beef production.

Trait	Approximate Heritability(%)	Sources of Information
Conception Rate	5	- BHIP: calving interval - Bull Test: scrotal circumference
Calving Ease	10	- Birth weight if recorded - NSMP: EPD
Birth Weight	40	- actual weight if recorded
Milk Yield	25	- BHIP: weaning index adjusted weaning weight*
Weaning Weight	30	- BHIP: weaning index adjusted weaning weight* - NSMP: EPD
Post-weaning rate of gain	45	- BHIP: gain index - Bull Test: gain index
Yearling Weight	45	- BHIP: composite index adjusted yearling weight* - NSMP: EPD
Finishing Ability	50	- Bull Test: backfat
Muscling (retail yield percent)	40	- visual appraisal - Bull Test: height, weight and backfat

*useful only within management groups

BREEDING GOALS

To this point, a great number of traits have been identified as having a potential impact on the profitability of beef production. Individual producers must determine their breeding goals by identifying those traits that are of economic importance to their particular operation. One way of doing this is to use a profit equation approach. Since the factors affecting profitability are unique for each farm, the profit equations and breeding goals will also be unique. Below are two examples of using a profit equation approach to determine breeding goals.

Example 1.

John has a herd of 40 Angus X Hereford cows and a Charolais bull. Having a woodworking business in a shop close to the calving area allows John to assist any difficult calvings. All calves are sold at weaning at the local market. Replacement heifers are purchased from neighbouring farms. Defining profit as income less expense, we can identify those factors that affect the profitability of John's operation.

Profit = Income − Expense

Now defining income and expense on John's farm:

$$\text{Profit} = \left[\text{\# of calves sold} \times \text{weaning weight} \times \text{price received per cwt.}\right] - \text{cost of maintaining the cow herd}$$

We can now identify factors that will impact on each of these components and look at their relative importance (Table 4).

Table 4. Factors affecting profitability of John's farm.

COMPONENT	INFLUENTIAL FACTORS	RELATIVE IMPORTANCE
# of calves sold	- conception rate	- high
	- calving ease	- low since John has time to assist

(Table 4 Continued)

COMPONENT	INFLUENTIAL FACTORS	RELATIVE IMPORTANCE
Weaning Weight	- milk yield	- high when selecting other producers calves as replacement heifers - of no importance when selecting a bull since no daughters are kept as replacements
	- pre-weaning growth rate	- high
Price Received ($/cwt)	- muscling, weight	- high if premiums and/or discounts exist
	- finishing ability	- high if buyer can identify John's calves as having excess or too little finishing ability
Cost of Maintaining the Cow Herd	- mature weight, milk yield	- high since moderately sized cows with adequate milk yield bred to large bull will yield similar product with less maintenance costs.

From this exercise we can conclude that John's goals should be: a high rate of conception; replacement heifers of moderate size with high milk yield; and well muscled sires with high rates of gain. In order to achieve these goals, John could refer to Table 3 in order to find sources of information relating to the traits that have been identified as being economically important.

Example 2.

Fred runs a mixed farming operation including farrow to finish, cash crop and a 25 cow herd with calves fed to market finish. Because of spring planting, Fred has little or no time to assist calving cows. Replacement heifers are kept from within the herd while all other calves are fed until they are sold at market finish. Fred sells all market animals to a local butcher who prefers B1 carcasses and does not discount for light or heavy carcasses. Following the same steps as for John, we see:

Profit = Income − Expense

Profit = [# sold X market weight X price received per cwt]
 − [cow costs + feedlot feed costs + feedlot overhead]

Table 5. Factors affecting profitability on Fred's farm.

COMPONENT	INFLUENTIAL FACTORS	RELATIVE IMPORTANCE
# sold	- conception rate	- high
	- calving ease	- high
Market Weight	- milk yield	- high since replacement heifers are kept
	- weaning weight	- moderate
	- post-weaning rate of growth	- high
	- finishing ability	- low
Price received ($/cwt)	- market weight	- low
	- finishing ability	- low
	- muscling	- high if premiums or discounts exist
Cow Costs	- mature weight, milk yield	- high
Feedlot Feed Costs	- feed efficiency	- high
Feedlot Overhead	- rate of gain	- high
	- finishing ability	- low

Fred should have goals as follows: cows that are moderate in size (to allow adequate production with reduced calving difficulty), with high rate of conception; sires with high rates of gain, good muscling, and ease of calving. Again, Table 3 could be used to identify sources of information regarding these traits.

The above examples illustrate how breeding goals will differ depending upon the details of each production system. When identifying breeding goals, one must consider both the economic impact and the heritability of each trait. Traits that are low in heritability should be improved through culling since little progress would be made through selection.

RESPONSE TO SELECTION

Once specific traits have been identified and selected for, one should be able to chart a response to selection. Table 7 shows average Ontario birth and weaning weights that have been recorded for the BHIP program. Reduced birth weights and increased weaning weights are a result of both selection and altered management practices.

Table 6. Average birth and weaning weights as recorded by BHIP.

Year	Average Birth Weight (lb.)	# of Calves*	Average Adjusted Weaning Weight (lb.)	# of Calves
1984	84	2,627	455	27,915
1985	82	15,198	519	46,038
1986	82	24,812	526	100,491

* Only those calves weighed at birth are included. There are more records for adjusted weaning weight since breed average birth weight is used in its calculation when actual birth weight is not available.

By using all available performance information, producers should begin to achieve their specific breeding goals. Success in meeting ones breeding goals should cause an overall increase in both productivity and profitability.

All animals must be uniquely identified in order that accurate meaningful records may be collected.

Weighing of animals allows comparisons to be made based on productivity.

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YOUR FARM

Defining ones breeding goals is often the hardest part of forming a successful breeding program. Breeding goals will differ from one producer to the next due to available resources and breeder preference. By using a profit equation approach and completing Table 7, producers can arrive at a preliminary set of breeding goals. These goals may change over time.

Table 7. Breeding goals for your farm.

Trait	Relative Importance (check one) Low	Medium	High	Desired Level	
Conception Rate					%
Birth Weight					lb
Milk Yield					
Preweaning Growth Rate					lb/day
Postweaning Growth Rate					lb/day
Muscling					
Finishing Ability					lb at A1 finish
Mature Weight (Cows)					lb
Temperament					
Horn Condition					
Colour					

Response to selection in your own herd can be charted using Table 8. Major advances or setbacks in any given trait may be the result of selection, culling and/or changes in environment and/or management practices (eg. creep feeding).

Table 8. Response to selection on your farm.

Year	# of Calves	Average Birth Weight	Average Adjusted Weaning Weight	Average Adjusted Yearling Weight	Comments*
1984					
1985					
1986					
1987					
1988					
1989					
1990					

*Includes any change of management that may have affected performance.

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Weaning Index

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1. Calves are compared only with others in the same management group. (Similar housing, feed, etc.)	At least 5 calves born within a 90 day period and raised in a common environment.
2. Preweaning average daily gain is calculated as: weaning weight − birth weight / age at weaning	525 − 75 / 197 = 2.28 lb/day
Weaning weight must be taken between 120 and 250 days of age. If birth weight is not recorded, breed averages are used for sire and dam contributions with adjustments made for age of cow (Table 1). Birthweight of twin calves is adjusted downward by 30% if table values are used.	If birth weight had not been recorded, the value of 79.9 (sire) + 81.7 (dam) / 2 = or 81 lb would be used.
3. Calves of young cows are at a disadvantage since milk production is higher for older cows. The average daily gain of calves from immature cows (less than 5 years old) is adjusted upwards to account for this (Table 2).	2.28 + 108 = 2.39 lb/day
4. In order to allow comparison of all calves, regardless of sex, average daily gain is adjusted to a bull basis. Rate of gain for heifers is increased by 10%, that of steers by 5% for the period of time since castration, while that of bulls remains the same.	2.39 + (2.39 x .10) = 2.63 lb/day
5. We now compare the adjusted average daily gain to the average for that management group to arrive at a weaning index.	Assuming an average adjusted rate of gain of 2.35 lb/day for the management group, weaning index equals: 2.63 x 100 = 112 / 2.35

When calculating a weaning index for twin calves (both raised by their mother), add 20% to their adjusted average daily gains. Compare these gains to the calculated management group average with the twin values not included.